Designation: D 1739 – 98

Standard Test Method for Collection and Measurement of Dustfall (Settleable Particulate Matter)[1]

This standard is issued under the fixed designation D 1739; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a procedure for collection of dustfall and its measurement. This test method is not appropriate for determination of the dustfall rate in small areas affected by specific sources. This test method describes determination of both water-soluble and insoluble particulate matter.

1.2 This test method is inappropriate for industrial hygiene use except where other more specific methods are also used.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

B 57 Specifications for Copper-Alloy Condenser Tube Plates[2]

D 1193 Specification for Reagent Water[3]

D 1356 Terminology Relating to Sampling and Analysis of Atmospheres[4]

E 11 Specification for Wire Cloth Sieves for Testing Purposes[5]

E 380 Practice for the Use of the International System of Units (SI) (the Modernized Metric System)[6]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology D 1356. An explanation of units, symbols, and conversion factors may be found in Practice E 380.

3.2 *Definition of Terms Specific to This Standard:*

3.2.1 *settleable particulate material*—any material composed of particles small enough to pass through a 1-mm screen (see Specification E 11) and large enough to settle by virtue of their weight into the container from the ambient air.

4. Summary of Test Method

4.1 Containers of a standard size and shape are prepared and sealed in a laboratory and then opened and set up at appropriately chosen sites so that particulate matter can settle into them for periods of about 30 days. The containers are then closed and returned to the laboratory. The masses of the water-soluble and -insoluble components of the material collected are determined. The results are reported as grams per square metre per 30 days $g/(m^2 \cdot 30\ d)$.

5. Significance and Use

5.1 This test method has the advantage of extreme simplicity. It is a crude and non-specific test method, but it is useful in the study of long-term trends. It requires very little investment in equipment and can be carried out without a large technically-skilled staff.

5.2 This test method is useful for obtaining samples of settleable particulate matter for further chemical analysis (1)[7].

6. Interferences

6.1 The results from this test method are obtained by weighings. Any material that gets into the container and passes through the sieve used in analysis, but which did not settle into the container after air entrainment can be considered an interferent.

7. Apparatus

7.1 *Container*—An open-topped cylinder not less than 150 mm (6 in.) in diameter with height not less than twice its diameter. Containers should be made of stainless steel or weatherproof plastic. They shall be capable of accepting legible, weatherproof, identification markings. A tight-fitting lid is needed for each container.

7.2 *Stand, for the container,* which will hold the top of the container at a height of 2 m above ground. It will also include a wind shield constructed according to Figs. 1 and 2. Experi-

[1] This test method is under the jurisdiction of ASTM Committee D-22 on Sampling and Analysis of Atmospheres, and is the direct responsibility of Subcommittee D22.03 on Ambient Atmospheres and Source Emissions.

Current edition approved Oct. 10, 1998. Published December 1998. Originally published as D 1739 – 60 T. Last previous edition D 1739 – 89 (1993)ε1.

[2] Discontinued, see *1992 Annual Book of ASTM Standards*, Vol 02.01—Replaced by B 171.

[3] *Annual Book of ASTM Standards*, Vol 11.01.

[4] *Annual Book of ASTM Standards*, Vol 11.03.

[5] *Annual Book of ASTM Standards*, Vol 14.02.

[6] Discontinued: see *1997 Annual Book of ASTM Standards*, Vol 14.02—Replaced by IEEE/ASTM SI 10.

[7] The boldface numbers in parentheses refer to the list of references at the end of this test method.

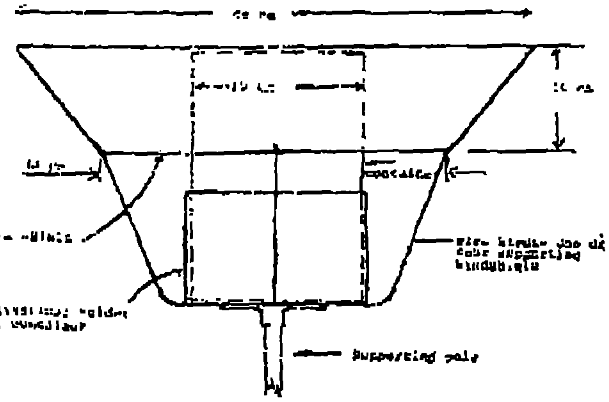

FIG. 1 Wind Shield for Dustfall Container

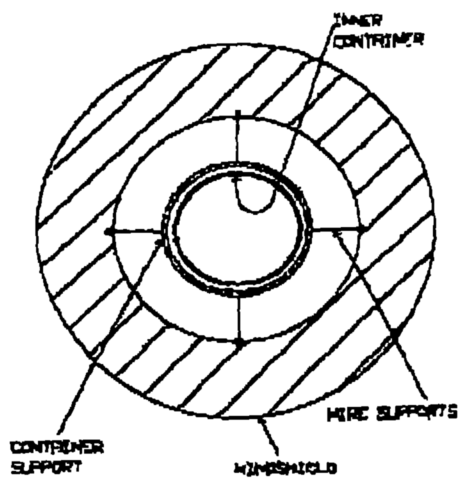

FIG. 2 Plan View of Wind Shield

ments reported in Kohler and Fleck (2) indicate that much better precision is obtained when this simple aerodynamic shield is provided, and that there is a wide variability in the concentration of particles subject to settling at heights of less than 2 m.

7.3 *Sieve*, 1 mm (No. 18), stainless steel.

7.4 *Drying Oven*, with temperature controlled at 105°C.

7.5 *Buchner Funnel*, and 2 L filtering flask.

7.6 *Filter Paper*, fast filtering type, circles to fit the Buchner funnel.

7.7 *Evaporating Dishes*, 100-mL capacity, capable of being unambiguously identified.

7.8 *Desiccators*.

7.9 *Analytical Balance*, to weigh with a precision of ±0.1 mg.

7.10 *Flexible Spatula*.

7.11 *Crate*, or frame in which to carry the containers.

7.12 *Graduated Cylinder*, 1 L capacity, whose graduations have been checked for calibration accuracy, ±5 mL, using, for example, volumetric flasks or pipettes.

8. Reagents

8.1 *Purity of Water*—Unless otherwise indicated, reference to water shall be understood to mean reagent water as defined by Type II of Specification D 1193.

9. Sampling

9.1 *Sites* (3, 4); for general sampling strategy, see Specifications B 57.

9.1.1 *Location:*

9.1.1.1 These recommendations are a guide to the selection of a site. In cases where these guidelines cannot be followed, results should only be presented accompanied by an appropriate caveat.

9.1.1.2 The sampling site should be in an open area, free of structures higher than 1 m within a 20-m radius of the container stand. It should be away from local sources of pollution and objects that could affect the settling of particulate matter, such as trees, and air exhausts and intakes. Accessibility and security from vandalism are major considerations in the selection of a site.

9.1.1.3 Elevations to higher objects within 20 m should not exceed 30° from the horizontal.

9.1.1.4 Open areas around police and fire stations and libraries are often suitable because of their accessibility and security.

9.1.1.5 Avoid siting the containers near chimneys. Whenever possible, the sampling site shall be more than ten stack-lengths from an operating stack and upwind from it according to the most frequent wind direction.

NOTE 1—Do not assume that stacks are unused without making direct inquiry.

9.1.2 *Number of Sites* (5)—For each region to be surveyed, a minimum of four sampling sites shall be provided, to allow for rejected samples and to provide some evidence for quality assurance checks. An orderly spacing of the stations should be made approximately at the vertices of an equilateral triangular grid. The availability of staff will often be a constraining factor, but it is suggested that the spacing between sites be between 5 and 8 km.

9.1.3 *Site Records*—A file which will contain physical information specific to each site, such as the approximate elevation above sea level, map co-ordinates, and so forth, should be maintained for each site. It should include a detailed description, or photographs of the container stand that include its surroundings. Also included should be photographs or detailed descriptions of the surrounding area in the four compass point directions from the container stand. Unusual activities occurring in the neighborhood of the site that emit large amounts of particulate matter into the air should be recorded in the site file. Such events are fires, construction and demolition work, traffic diversions, and so forth. Records of these events will greatly increase the value of the data gathered from this test method. Records of rain and snowfall for the sites may also be helpful in interpreting the results from this test method.

9.2 *Preparation of the Containers*—Thoroughly clean the containers and lids, using detergent solution. Rinse the containers twice with reagent water. The containers should be sealed with their lids, labelled with identification numbers, and placed in the rack or crate.

9.3 *Sample Collection:*

9.3.1 Set out the containers at the sites. Record the date, time and identification number as each container is set out and its lid removed.

9.3.2 At the end of the sampling period, reseal the containers with their lids and place them in the crates or racks and return them to the laboratory for analysis. The date and time of pick up and the identification number of the containers should be recorded at each site as they are collected.

9.3.3 Rain or snow will collect in and evaporate from the containers during the exposure period, and containers may have liquid in them when they are picked up. This liquid is later processed and therefore should not be discarded. If enough inches of rain or snow are known to have fallen at a site that it is likely that the container was filled with either, the corresponding sample should be voided.

9.4 *Sampling Period*—The sampling period shall be one calendar month with an allowance of ±2 days permissible when the set-out and pick-up dates are chosen. Results are normalized to a thirty day period.

9.5 *Handling:*

9.5.1 No attempt should be made to remove the collected material from the containers at the sampling site.

9.5.2 As the containers are loaded into the crates to go to the field and again after they are returned to the laboratory, records should be made in a permanent log book. The outgoing and incoming records should be reconciled immediately and any discrepancies investigated immediately, so that missing samples can be found before their exposure period exceeds the maximum permissible 32 days.

10. Procedure

10.1 The procedures are described below in terms of a single sample, but normally many samples will be analyzed simultaneously using multiple evaporating dishes, filters, etc.

10.2 *Insoluble Matter:*

10.2.1 Prepare an evaporating dish by washing, drying and marking it with an identification number.

10.2.2 Place a folded filter paper in the prepared dish and dry it for at least 1 h in the oven. Cool it in the desiccator, then weigh the filter in the dish to the nearest 0.1 mg. Record the weight as the tare weight for insoluble matter.

10.2.3 Seat the filter paper (10.2.2) in the Buchner funnel by wetting it with a small amount of reagent water. Place the funnel on the filter flask. If the container to be analyzed is dry or has less than 200 mL of water in it, add enough reagent water to it to bring the volume of liquid up to about 200 mL. Swirl the water around to entrain the settled particulate matter. Use a clean flexible spatula rinsed with reagent water to swab down the walls of the container and ensure that all the particulate matter is freed from the walls and bottom of the container. Pour the liquid and entrained particulate matter into the filter funnel through the No. 18 sieve. The filtrate collected in the flask will be used later for determination of soluble matter.

10.2.4 Measure and record the volume of the filtrate in the graduated cylinder and retain it for determination of the soluble material. Rinse the container with approximately 100 mL of reagent water and transfer any solid material remaining in the container to the filter through the sieve, using the flexible spatula if necessary. Discard the filtrate from the rinsing and any material retained by the sieve.

10.2.5 Remove the filter paper with the insoluble material from the filter funnel, place it in the tared dish and put them in the oven for at least 90 min. Cool them in a desiccator for at least 1 h. Weigh the dried dish and filter with insoluble material to within 0.1 mg. Repeat the drying procedure until a constant mass is obtained.

10.2.6 Calculate the weight of insoluble particulate matter by deducting the tare weight of the filter and dish from the weight found in 10.2.5.

10.3 *Total Soluble Matter:*

10.3.1 Prepare an evaporating dish as in 10.2.1.

10.3.2 Put all, or a measured 500 mL, whichever is less, of the filtrate from 10.2.4 into a 1000 mL beaker. Concentrate the solution slowly to approximately 50 mL on a hot plate by boiling away water. If the total filtrate volume was less than 500 mL, make note of this fact.

10.3.3 Dry the prepared evaporating dish in the oven and cool it in the desiccator. Weigh it and record the weight to the nearest 0.1 mg as the tare weight.

10.3.4 Quantitatively transfer the concentrated filtrate from 10.3.1 to the tared dish and continue the evaporation very slowly on a hot-plate to dryness. Dry the dish and contents in the oven for 2 h, and cool in the desiccator for at least 1 h. Weigh the evaporating dish and contents and record the mass to the nearest 0.1 mg. Repeat the drying and cooling until a constant mass is obtained.

10.3.5 Calculate the net mass of the material dissolved in the solution taken in 10.3.1 by subtracting the tare mass from the mass determined in 10.3.3. If the whole volume of the filtrate was not taken in 10.3.1, normalize the net mass to the whole volume. Report the resultant figure as soluble particulate matter.

11. Calculation

11.1 Calculate a deposition rate, D, in grams/square meter/30 day period, g/(m^2 30 d), for the two masses of material obtained in Section 10:

$$D = W/A \; g/(m^2/30)$$

where:

A = collection area, the cross sectional area of the inside diameter of the top of the container, m^2, and

W = masses determined in 10.2 and 10.3, normalized if necessary to a 30 day period, g.

12. Precision and Bias (2, 3, 7)

12.1 An investigation into the precision of this test method (a similar method now being withdrawn) was made as part of an interlaboratory study of air pollution monitoring methods called Project Threshold in 1968. The test method as then defined was not exactly the one described in this standard. The container was not equipped with the aerodynamic shield defined now, and the height for the container was much less loosely defined. In addition, the acceptance criteria for sites were not as stringent as in this standard; roof-top locations were acceptable. Meetham (6) reports a strong variation in the amount of sample collected in containers at the same site separated by vertical height. The results from Project Threshold are presented in 12.1.2 through 12.1.7 and more information is available with respect to the precision to be expected in sampling with different types of containers in Ref 6.

12.1.1 *Reproducibility*—The standard deviation for variations among single dustfall measurements by different laboratories is 1.46 g/(m^2· 30 d) and is associated with a mean dustfall of 6.45 g/(m^2· 30 d). Measurements at three dustfall rates over the range of 3.28 to 10.47 g/(m^2· 30 d) do not exhibit an apparent relationship between dustfall rate and reproducibility.

12.1.2 *Repeatability*—The standard deviation for variations among repeated dustfall measurements within laboratories is 1.03 g/(m^2· 30 d) and is associated with a mean dustfall of 6.45 g/(m^2· 30 d). Measurements at three dustfall rates in the range of 3.28 to 10.47 g/(m^2· 30 d) did not show an apparent relationship between dustfall rate and repeatability.

12.1.3 Known quantities of water soluble and water insoluble particulate materials were added to some dustfall samples after their collection and prior to analysis. The average recovery of the dust spikes was 96 % based upon all measurements. The standard deviation of the spike recovery measurements is 16 %.

12.1.4 The standard deviations of between- and within-laboratory determinations of the water insoluble fraction of the ambient dustfall samples are 1.18 and 0.78 g/(m^2· 30 d) respectively, and are associated with a mean water insoluble dustfall of 3.50 g/(m^2· 30 d).

12.1.5 The average recovery of water insoluble dustfall spikes by all laboratories and at all sites is 91 % and the standard deviation of the recovery measurements is 18 %.

12.1.6 The standard deviations of between- and within-laboratory determinations of the water soluble fraction of ambient dustfall samples are 1.64 and 0.59 g/(m^2· 30 d), respectively and are associated with a mean water soluble dustfall of 2.59 g/(m^2· 30 d).

12.1.7 The average recovery of water soluble dustfall spikes by all laboratories and at all sites is 95 % and the standard deviation of the recovery measurements is 37 %.

12.2 Better results were obtained by Kohler and Fleck (2) using the aerodynamic vane specified in this test method.

13. Keywords

13.1 ambient atmospheres; dustfall; settleable particulate matter

REFERENCES

(1) Schultz, E., "Size Fractional Measurements of Coarse Black Carbon Particles in Deposition Samples," *Atmospheric Environment*, Vol 27 A (8), 1993, pp. 1241–50.

(2) Kohler A., and Fleck W., "Comparative Dust Precipitation and Dust Concentration Measurements," *Staub, Reinhaltung der Luft*, Vol 26, No. 3, March 1966.

(3) Nader, J. S., "Dust Retention Efficiencies of Dustfall Collectors," *Journal of the Air Pollution Control Association*, Vol 8, 1958, pp. 35 to 38.

(4) Katz, M., "Standardization of Methods of Sampling and Analysis," *Proceedings of International Clean Air Conference* (London), 1959, pp 147–152.

(5) "Recommended Methods for Continuing Dustfall Surveys," (APM-1, Rev. 1), *Journal of the Air Pollution Control Association*, Vol 16, No. 7, 1966, pp. 372–377.

(6) Meetham, A. R., *Atmospheric Pollution: Its Origins and Prevention*, Pergamon Press, London, 3rd. edition, Chapter 11, 1964.

(7) Foster, J. F., Beatty, G. H., and Howes, J. E. Jr., "Interlaboratory Co-Operative Study of the Precision and Accuracy of the Measurement of Dustfall using ASTM Method D 1739," *ASTM Data Series Publication DS 55-S4*, ASTM, 1916 Race Street, Philadelphia, PA 19103.